

Evaluation of a spacecraft attitude and rate estimation algorithm

ABSTRACT

Purpose: This paper aims to present the development and performance evaluation of an attitude and rate estimation algorithm using an extended Kalman filter structure based on a body-referenced representation of the state.

Design/methodology/approach: The algorithm requires only geomagnetic field data and can be used as a low-cost alternative or as a back-up estimator in the case of attitude sensor failures. The satellite rate is estimated as a part of the filter state and thus no gyroscope is necessary. The assessment of the algorithm performance is realized through a Monte Carlo simulation using a low-Earth orbit, nadir-pointing satellite.

Findings: Given some attitude and rate error requirements, the range of admissible initial errors on the filter state and the effect of un-modelled disturbance torque are determined, along with the achievable attitude and rate accuracies.

Practical implications: Because the simulation set-up is clearly stated, the results of this evaluation can be used as a benchmark for other estimation algorithms.

Originality/value: The necessary assumptions and approximations used to derive the filter equations are explicitly pointed out for the benefit of the readers. Well-defined filter initial conditions are used in an extensive series of tests resulting into a unique set of findings.

Keyword: Spacecraft; Magnetic fields; Monte Carlo simulation; Estimation